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Preliminary Stratigraphic Framework of the Pliocene and Miocene Rhyolite, Eastern Snake River Plain, Idaho

by

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ABSTRACT

Recent field studies along the margins of the eastern Snake River Plain, Idaho, have disclosed an extensive and complex stratigraphic succession of Pliocene and Miocene rhyolite pyroclastic deposits. Basalt forms a relatively thin veneer that conceals a thick sequence of rhyolite and related calderas. Rhyolite is more voluminous than basalt in the plain.

Five regionally extensive ash-flow tuff units occur along the southeastern margin of the eastern Snake River Plain, and three occur on the northern margin. In order from oldest to youngest, the tuff units on the southeastern margin are as follows: (1) the tuff of Arbon Valley extending from east of the Sublett Range to Blackfoot, Idaho; (2) the tuff of Spring Creek (6.5 million years) extending from Blackfoot to the eastern margin of the Rexburg caldera complex; (3) the Walcott Tuff which is present along the Snake River canyon and extends from the Sublett Range to the Bannock Range; (4) the tuff of Elkhorn Spring exposed in the southern part of the Rexburg caldera complex; and (5) the 4.3-million-year-old tuff of Heise, extending from Blackfoot to Teton National Park. The northern units from the oldest to youngest are as follows: (1) the tuff of Edie Ranch exposed in the southern Beaverhead and Centennial Mountains and the southern Lost River and Lemhi Ranges; (2) the tuff of Blue Creek exposed in the southern Lemhi Range and Beaverhead Mountains; and (3) the tuff of Kilgore, extending from at least the southern Lemhi Range to the southern foothills of the Centennial Mountains north of Kilgore, Idaho. Ages and total extent of all these units have yet to be determined.

The Rexburg caldera complex was the source of the tuff of Spring Creek. The tuff of Edie Ranch is similar to the tuff of Spring Creek petrographically and stratigraphically and is correlated with the tuff of Spring Creek. From geophysical and geological data, the tuffs of Blue Creek and Elkhorn Spring are interpreted as being equivalent units and having an eruptive center located south and east of the Lemhi Range and south of the Beaverhead Mountains. The tuff of Kilgore and the tuff of Heise are equivalent and have an eruptive center near Kilgore, Idaho.

INTRODUCTION

The Snake River Plain (Figure 1) is a structural graben which has been considered a Cenozoic basalt province (Stearns and others, 1939; Armstrong and others, 1975; Smith and Christiansen, 1980). However, subsurface drilling, geophysical studies, and recent mapping on the margins of the eastern Snake River Plain reveal that rhyolite is considerably more voluminous than basalt in this bimodal volcanic province (H. J. Prostka, G. F. Embree, D. J. Doherty, and L. A. McBroome, unpublished field data, 1972-1980). The basalt lava flows form a relatively thin veneer over a thick sequence of rhyolitic ash-flow tuff sheets and lava flows (Figures 2 and 3; Doherty, 1979a, 1979b; Doherty and others, 1979; Embree and others, 1979). More than 2,400 meters of rhyolite was found in a 3,160-meter-deep exploratory geothermal test well (INEL-1) beneath 745 meters of basalt and intercalated sediments (L. A. McBroome and D. J. Doherty, unpublished data, 1981).

This paper presents a brief and preliminary overview of the late Cenozoic rhyolite stratigraphy of the eastern Snake River Plain. Five regionally extensive ash-flow tuff sheets are the key units which form the framework of the rhyolite stratigraphy (Figure 4). We show the general distribution and relative ages of these units as well as the present interpretations on the locations of some of the source calderas for the ash-flow sheets.

The idea that rhyolite units and associated eruptive centers are concealed beneath the veneer of basalt lava flows of the eastern Snake River Plain is not

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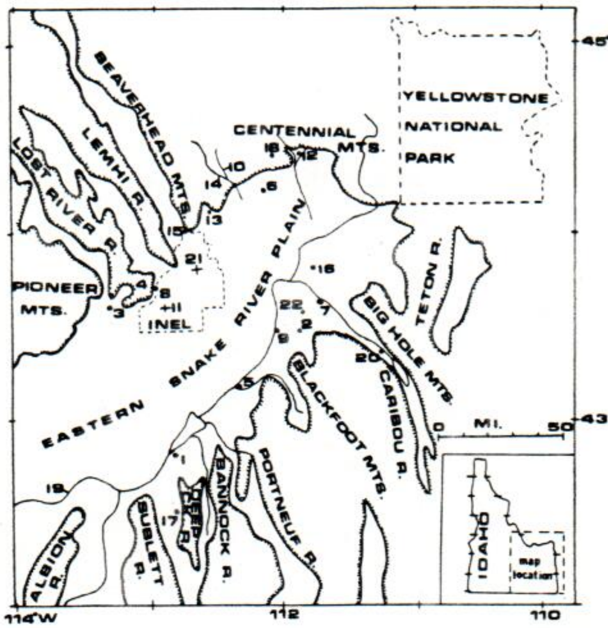

Figure 1. Index map of the eastern Snake River Plain, southeast Idaho. 1—American Falls, 2—Ammon, 3—Arco, 4—Arco Hills, 5—Blackfoot, 6—Dubois, 7—Heise, 8—Howe, 9—Idaho Falls, 10—Indian Creek, 11—INEL-1, 12—Kilgore, 13—Lidy Hot Springs, 14—Medicine Lodge Creek, 15—Reno Point, 16—Rexburg, 17—Rockland, 18—Signal Mountain, 19—Snake River, 20—Swan Valley, 21—Well 2-2A, 22—Willow Creek.

new. Mansfield and Ross (1935) commented on the general similarity in the appearance of the welded tuff sheets present on the northern and southern margins of the eastern Snake River Plain and suggested these rhyolite units were possibly buried beneath the basalts and sediments of the plain. Stearns and others (1939) suggested that the units had different sources and that the major sources were a chain of silicic volcanoes which extended from Boise toward the Yellowstone Plateau along the axis of the Snake River Plain. Kirkham (1931) proposed that the volcanic rocks became progressively younger toward the Yellowstone Plateau. These concepts are similar to current models for the evolution of the eastern Snake River Plain (for example, Smith and Christiansen, 1980; Leeman, 1982 this volume; Mabey, 1982 this volume).

GENERAL GEOLOGY

The eastern Snake River Plain is a 90-kilometer-wide, northeast-trending basin which extends from the vicinity of Twin Falls on the southwest to Yellowstone National Park on the northeast (Figure 1). The plain truncates generally northwest-trending basin and range structures on the northwest and southeast, with 1,200 to 1,400 meters of relief between the ranges and the relatively flat surface of the plain. The Island Park area, which contains partial rims of two rhyolite calderas that now are partially filled with Pleistocene basalt lava flows (Hamilton, 1965; Christiansen and Blank, 1972; Christiansen, 1982 this volume), marks the transition between the eastern Snake River Plain and the topographically higher, younger Yellowstone rhyolite plateau to the northeast.

The surface of the plain consists of numerous Pleistocene basalt shield volcanoes and northwest-trending rift zones (Kuntz and others, 1982 this volume). The basalt overlies rhyolite ash-flow tuff sheets and lava flows, fan gravels, and local basalt units of Tertiary age along the margins of the plain. The Tertiary units, in turn, lap onto the older rocks and form dip slopes on the surrounding mountain ranges. The surrounding ranges are structurally asymmetric horsts with eastward dips. Tertiary ash-flow tuffs extend for more than 55 kilometers from the margins of the plain and form part of the valley-fill in the marginal asymmetric grabens.

The caldera model for the origin of the eastern Snake River Plain (Smith and Christiansen, 1980) suggests that a succession of Yellowstone-like calderas have propagated northeastward along the axis of the plain. These eruptive centers subsequently have subsided and been buried beneath younger volcanic and sedimentary deposits. Subsurface data support the model of flooding by basalt lava flows and eventual total burial of the old caldera systems. The data suggest that the basalt cover progressively becomes thicker to the southwest (Doherty, 1979a, 1979b; Doherty and others, 1979; Embree and others, 1979). Armstrong and others (1975) suggested that three general facies (silicic volcanic rocks, basalt lava flows, and lacustrine and fluvial sediments) have shifted progressively from west to east at an approximate rate of 3.5 centimeters a year along the axis of the plain based on their potassium-argon radiometric studies. Age determinations show that volcanic activity began in the western Snake River Plain about 14.2 million years ago (Armstrong and others, 1980) and gradually propagated northeastward along the axis of the plain with the most recent activity occurring 0.6 million years ago in the Yellowstone Plateau (Christiansen and Blank, 1972; Christiansen, 1982 this volume).

The initial stage in caldera development is illustrated by the present-day Yellowstone rhyolite plateau where the eruption of several large-volume ash-flow tuff sheets was followed by caldera collapse.

The second stage in caldera development on the eastern Snake River Plain involves the cessation of major rhyolitic activity and gradual subsidence, accompanied by filling and eventual burial of the caldera by basalt lava flows. The 1.2 and 1.9-million-year-old caldera rims at Island Park, which are temporally and spatially transitional between the most recent rhyolite units (0.6 million years old) of the Yellowstone area (Christiansen and Blank, 1972; Christiansen, 1982 this volume) and the Pliocene and Miocene rhyolite units of the eastern Snake River Plain, represent an early part of this stage. The interior as well as the southern and western flanks of the Island Park basin has been completely inundated by Pleistocene basalt flows (Hamilton, 1965; Christiansen, 1982 this volume).

A more advanced stage of burial is represented by a 6.5-million-year-old caldera near Rexburg on the eastern margin of the plain about 50 kilometers south of the Island Park caldera (Figures 1 and 3; Prostka and Embree, 1978; Prostka, 1979; Prostka and others, 1979). The Rexburg caldera complex is 55 kilometers in diameter. Tertiary rocks of the caldera complex, along with small segments of the caldera fault system, are exposed around the margins of the caldera. Juniper Buttes (Kuntz, 1979) at the north edge of the Rexburg caldera north of St. Anthony, Idaho, consists of Pliocene rhyolite and basalt protruding through the Quaternary basalt cover. For the most part, however, the rocks associated with Juniper Buttes have been buried beneath the 4.3-million-year-old tuff of Heise (Armstrong and others, 1980) and the 1.9-million-year-old Huckleberry Ridge Tuff (Christiansen and Blank, 1972; Christiansen, 1982 this volume), Pleistocene basalt, and loess. Well data reveal that the Tertiary rhyolite of the central and western parts of the Rexburg caldera complex has been further buried beneath at least 134 meters of Quaternary Snake River Group basalt (Figure 2; Embree and others, 1979).

The full extent of the Rexburg caldera complex and the location of its western margin have been inferred in part from gravity data. These data disclose a large negative anomaly superimposed on the regional gravity high of the eastern Snake River Plain (Figure 5; Mabey and others, 1974; Mabey, 1978). The circular shape of the negative gravity anomaly, in contrast to the elongate anomalies related to the basin and range structures north and south of the

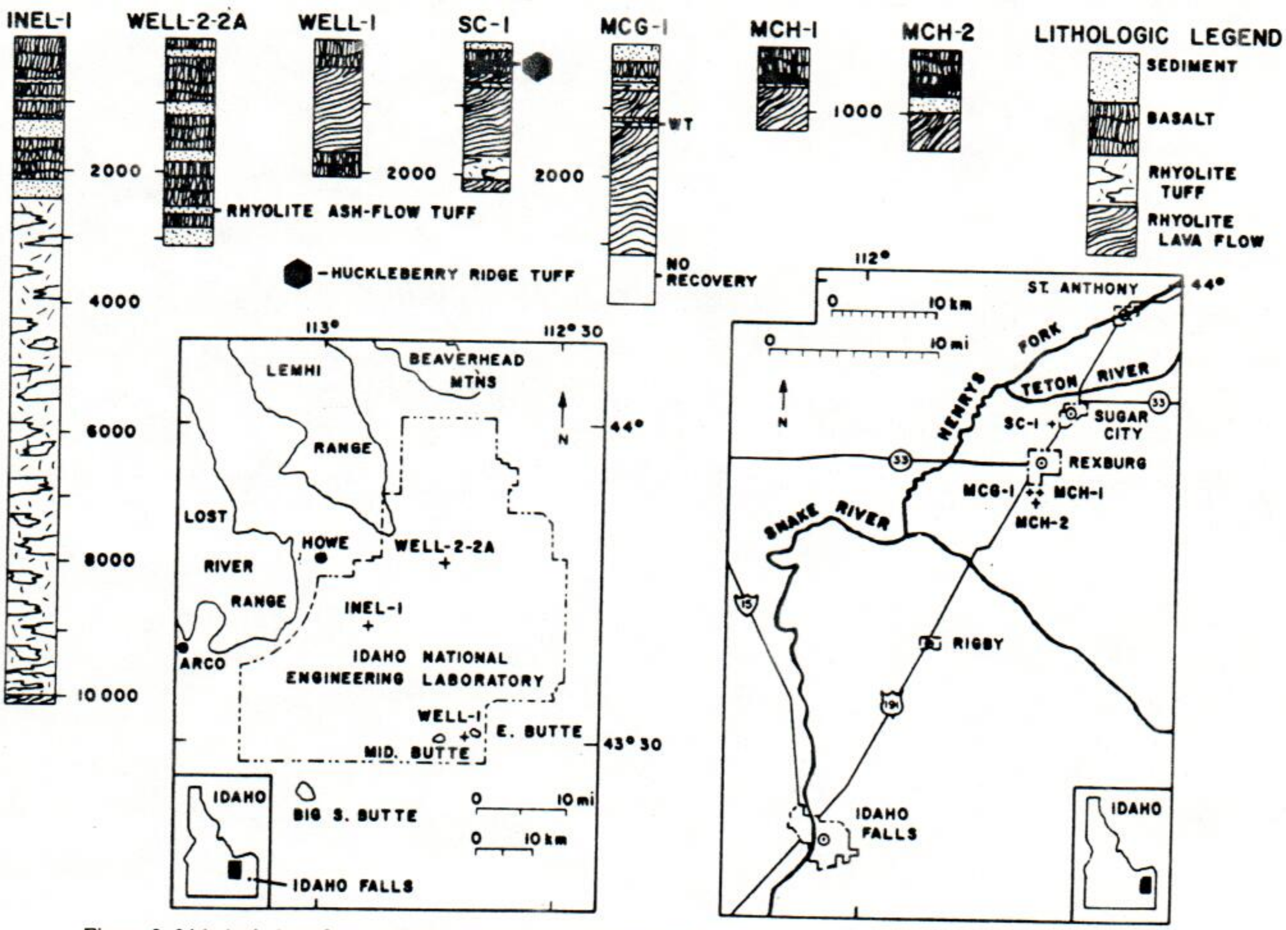

Figure 2. Lithologic logs from various exploratory boreholes on the eastern Snake River Plain (depths given in feet).

plain, suggests that the gravity low is related to a buried caldera. Mabey (1978) suggested that 1.0 to 2.5 kilometers of low-density caldera fill would account for an anomaly of this magnitude.

Geologic mapping, petrography, and regional gravity data suggest an area south and east of the Lemhi Range and south of the Beaverhead Mountains (Figure 5) as the site of a caldera that is buried even more deeply than the Rexburg caldera. The caldera is the source for the tuff of Blue Creek (McBroome, 1981).

The source caldera for the tuff of Blue Creek differs from the Rexburg caldera complex in that the Blue Creek caldera is centered on a positive gravity anomaly. Data obtained from the 3,160-meter-deep exploratory geothermal test well, INEL-1 (Figure 1), may provide an additional explanation. In the test well, 745 meters of basalt and intercalated tuffaceous sediments were found above 2,400 meters of intracauldron rhyolite (Doherty and others, 1979). Approximately 60 meters of dense latite (L. A. McBroome and D. J. Doherty, unpublished data, 1981) was found at the bottom of the test well; the denseness of the latite may be due to hydrothermal mineralization within a ring-fracture zone and may account for the positive gravity anomaly. No intrusive body is known to be associated with the Rexburg caldera complex. Gravity data as well as seismic refraction and borehole data suggest that the denser body is surrounded

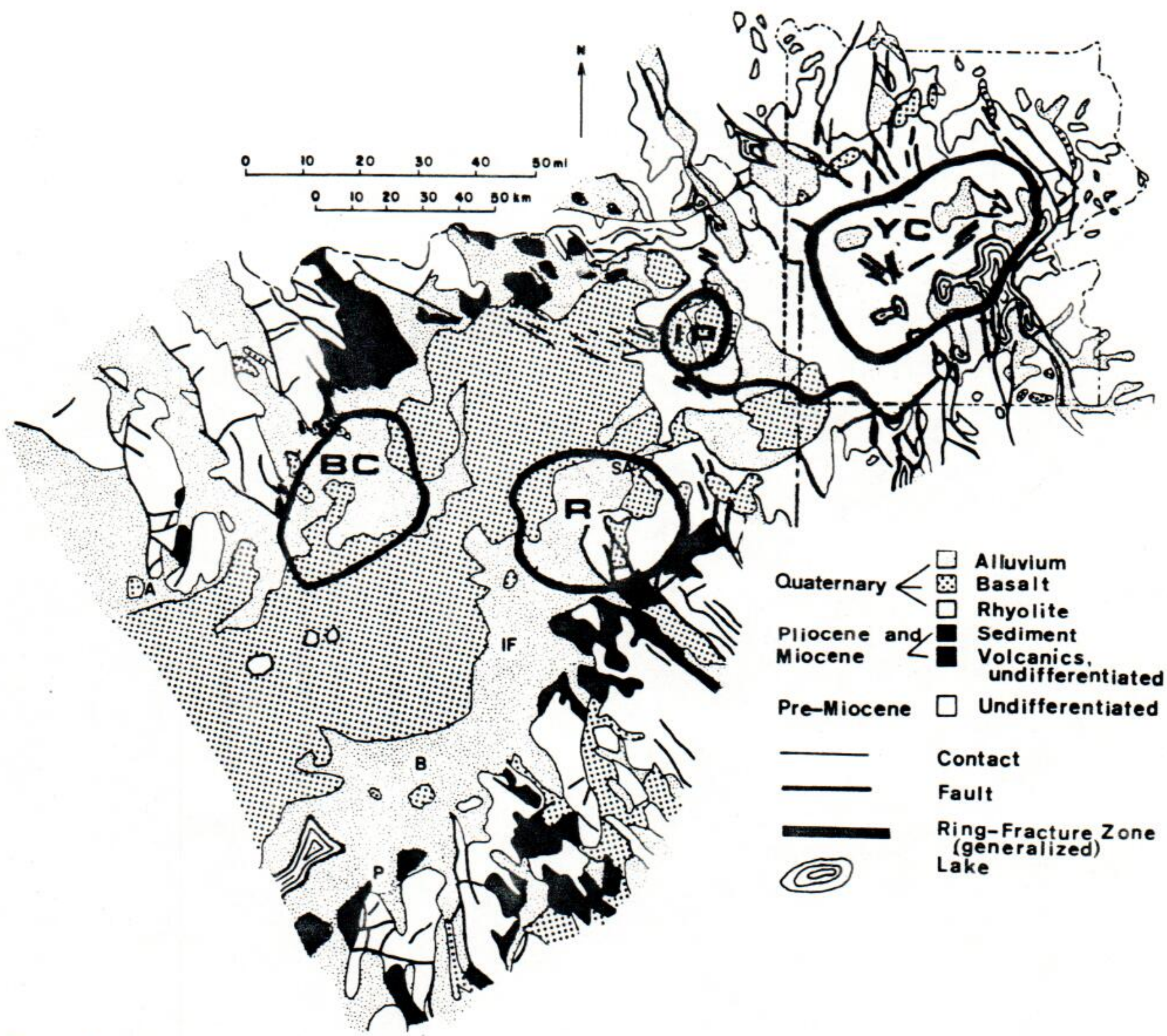

Figure 3. Generalized geologic map of the eastern Snake River Plain, Idaho, and Yellowstone National Park area modified from Bond (1978) and Smith and Christiansen (1980). A—Arco; B—Blackfoot; IF—Idaho Falls; SA—St. Anthony; P—Pocatello; BC—Blue Creek caldera; R—Rexburg caldera complex; IP—Island Park caldera; YC—Yellowstone caldera.

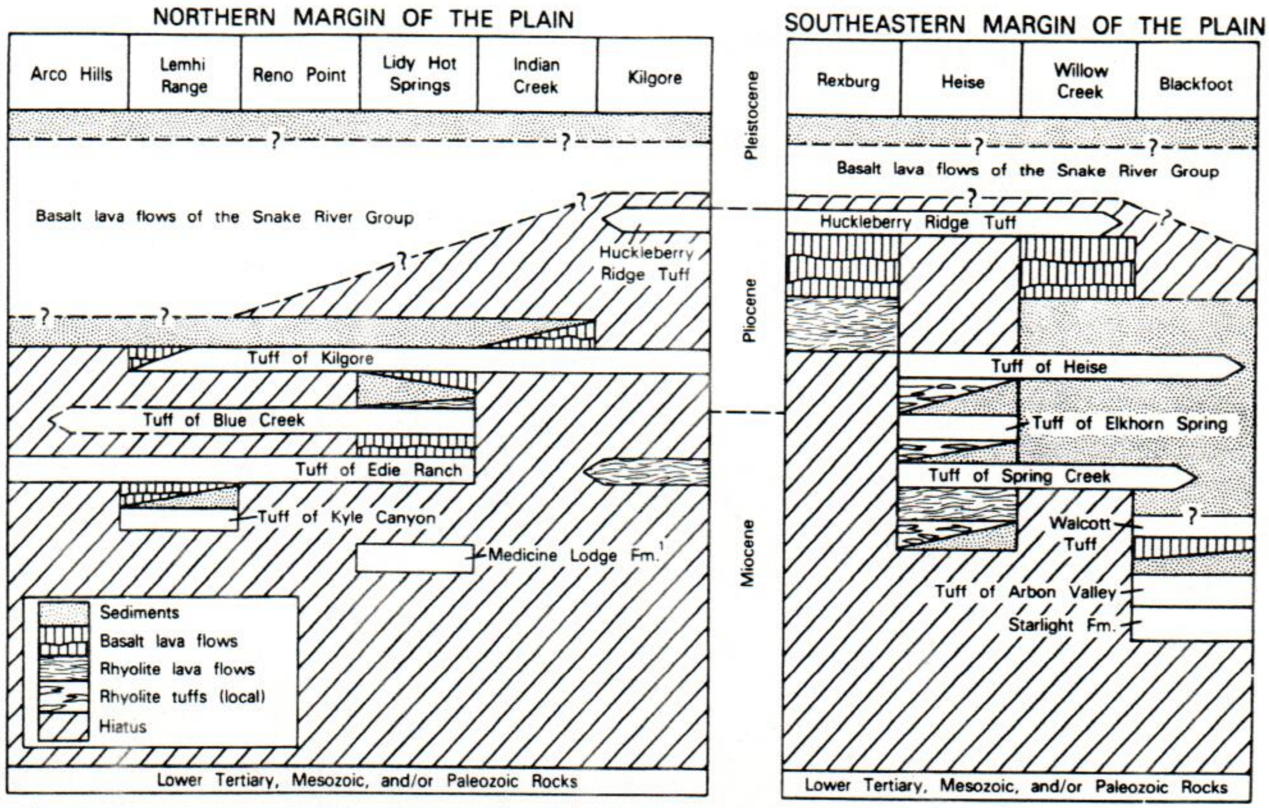

Figure 4. Correlation chart of stratigraphic units on both margins of the eastern Snake River Plain. (1) Scholten and others (1955).

by less dense rhyolitic pyroclastic deposits on the west and less dense tuffaceous lacustrine sediments on the east. The interpretation that less dense rhyolitic pyroclastic deposits are present west of the positive gravity anomaly is supported by seismic refraction data (Pankratz and Ackermann, 1981). Less dense tuffaceous sediment is interpreted to be present east of the positive gravity anomaly, as approximately 100 meters of tuffaceous sediment was recovered in the geothermal exploratory test well 2-2A (Figures 1 and 2; Doherty, 1979a) located in sec. 22, T. 2 N., R. 31 E. The positive gravity anomaly may have been enhanced by resurgence of the collapsed caldera or by a thicker accumulation of basalt lava flows within the caldera than in the adjacent region (McBroome, 1981).

The Island Park, Rexburg, and Blue Creek calderas, in connection with the borehole data obtained from the wells drilled near INEL and Rexburg (Figure 2) and major ash-flow sheets along the margins of the eastern Snake River Plain, suggest the existence of other large calderas concealed beneath the basalt elsewhere on the plain. The precise location of these calderas requires, among other things, a detailed examination of the structural and stratigraphic relations between the individual ash-flow tuff units produced by the major caldera-forming eruptions. The outflow facies of these ash-flow units, as exposed at the margins of the plain, are described below.

MAJOR ASH-FLOW TUFFS ALONG THE SOUTHEASTERN MARGIN, EASTERN SNAKE RIVER PLAIN

TUFF OF ARBON VALLEY

The tuff of Arbon Valley is the middle member of the Starlight Formation (Carr and Trimble, 1963; Trimble, 1976; Trimble and Carr, 1976). It is exposed along the southern margin of the eastern Snake River Plain from the Rockland area on the east side of the Sublett Range to just north of the Blackfoot River in the Caribou Range. The tuff of Arbon Valley is a compound cooling unit 60 meters thick where it is exposed 6 kilometers east of Blackfoot, Idaho. The unit is generally less than 30 meters thick.

The lower half of the tuff is poorly welded to nonwelded and contains about 10 percent of silky white pumice fragments up to 6 centimeters in diameter. The matrix is white and partly devitrified and contains 5 percent phenocrysts of sanidine, betaquartz, plagioclase, and biotite.

The middle part of the unit is densely welded, devitrified, eutaxitic with gray pumice 1 to 3 centimeters long set in a white to medium gray matrix. The phenocryst content is much higher in the middle and upper parts of the unit, increasing from 20 to 30 percent. Predominant phenocrysts are quartz, sanidine, and biotite. Although making up less than 1 percent of the total phenocryst content, biotite is significant because the tuff of Arbon Valley is the only major biotite-bearing ash-flow tuff in the area of this study.

The uppermost part of the tuff of Arbon Valley has generally been removed by erosion. Where preserved, it is white and poorly welded.

A potassium-argon age of 7.7 ± 0.1 million years has been determined for the tuff of Arbon Valley by Armstrong and others (1975).

WALCOTT TUFF

The Walcott Tuff was named by Stearns and Isotoff (1956) to describe a densely welded, obsidian-rich, crystal-poor, rhyolitic ash-flow tuff that is exposed along portions of the Snake River canyon near American Falls, Idaho. It varies up to 20 meters in thickness and consists of two members (Carr and Trimble, 1963). The lower member is a white to light gray, bedded, friable, vitroclastic tuff. Some beds contain accretionary lapilli up to 2 millimeters in diameter. The lower member ranges in thickness from 2 to 4 meters.

The upper member consists of a gray to black and pink, vitric, densely welded to nonwelded, crystal-poor, rhyolitic ash-flow tuff. In general, phenocrysts amount to less than 5 percent and consist of plagioclase, sanidine, hypersthene, augite, and minor mag-

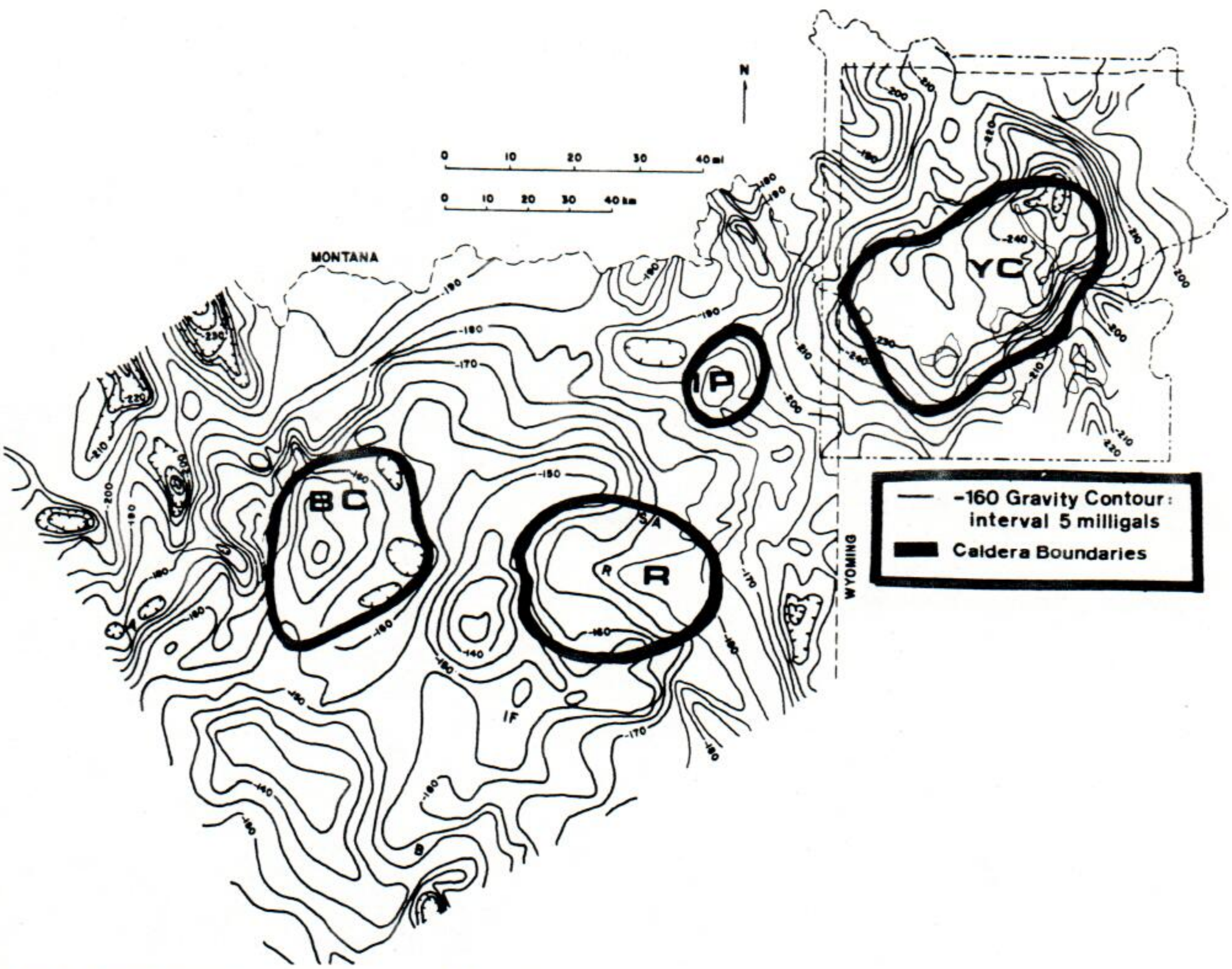

Figure 5. Gravity map of the eastern Snake River Plain, Idaho, and Yellowstone National Park area from Mabey and others (1974) and Smith and Christiansen (1980). The map shows the location of the Yellowstone (YC), Island Park (IP), Rexburg (R), and Blue Creek (BC) calderas. A—Arco; B—Blackfoot; IF—Idaho Falls; R—Rexburg; SA—St. Anthony.

netite. The thickness of the upper member ranges from 16 to 18 meters.

Carr and Trimble (1963) and Mansfield and Ross (1935, p. 310) suggest that the Walcott Tuff may correlate with a tuff unit near Ammon, Idaho, which Doherty (1981) described as the tuff of Heise, unit 2. The age of the Walcott Tuff, as determined by potassium-argon dating techniques, is 6.1 to 6.2 million years (Armstrong and others, 1975); the age of the tuff of Heise in the Ammon area is 4.3 ± 0.15 million years (Armstrong and others, 1980). Thus the tuff of Heise does not correlate with the Walcott Tuff.

TUFF OF SPRING CREEK

The type section for the tuff of Spring Creek has been described for exposures at Stinking Spring Creek (Prostka and Embree, 1978), located in sec. 10, T. 3 N., R. 41 E., Heise SE 7½-minute quadrangle; the tuff of Spring Creek originally was designated as the tuff of Heise A by Albee and others (1975).

The tuff of Spring Creek forms one of the most extensive Miocene ash-flow tuff sheets along the the southern margin of the eastern Snake River Plain. It is the oldest, large-volume, rhyolitic ash-flow tuff associated with the development of the Rexburg caldera complex which erupted 6.5 million years ago (Prostka and others, 1979). The tuff of Spring Creek is well exposed within and surrounding the southern and eastern segments of the complex; the tuff has been identified at least 50 kilometers south of the Rexburg caldera complex southeast of Blackfoot, Idaho. The exposed thickness of the tuff of Spring Creek ranges from 1 meter to at least 215 meters. Outside the caldera, the tuff of Spring Creek is well exposed in the western foothills of the Caribou Range where it occurs as an eroded and gently folded, discontinuous sheet that rests on Mesozoic sedimentary rocks.

The tuff of Spring Creek is typically densely welded, vitric to devitrified, eutaxitic, and in places, lithophysal. It is a gray to brown, crystal-rich tuff with phenocrysts of plagioclase, sanidine, quartz, augite, hypersthene, rare biotite, magnetite, and zircon. The tuff of Spring Creek is vertically zoned in phenocryst abundance and plagioclase composition. Phenocrysts constitute 15 to 20 percent of the rock near the base and gradually decrease to 3 to 5 percent near the top of the unit. Zoned plagioclase phenocrysts increase in anorthite content upward through the sheet from An_{27-37} at the base to An_{42-45} at the top. The lower part of the unit contains up to 2 percent green augite phenocrysts that are commonly corroded. Fluxgate magnetometer measurements show that the tuff of Spring Creek has normal magnetic polarity.

TUFF OF ELKHORN SPRING

The tuff of Elkhorn Spring has been described from its well-exposed type section near Elkhorn Spring, sec. 23, T. 4 N., R. 40 E., Heise 7½-minute quadrangle (Prostka and Embree, 1978). It was originally described as the tuff of Heise B by Albee and others (1975).

The tuff of Elkhorn Spring is a gray to purplish gray, devitrified, lithophysal to spherulitic, eutaxitic, densely welded, rhyolitic ash-flow tuff. Phenocrysts of plagioclase constitute less than 1 percent of the rock. The tuff ranges from 2 to approximately 70 meters in thickness. The tuff of Elkhorn Spring occurs above the 5.72-million-year-old (G. B. Dalrymple, personal communication, 1979) rhyolite of Kelly Canyon (Prostka and others, 1979) and below the 4.3-million-year-old tuff of Heise (Armstrong and others, 1980).

The tuff of Elkhorn Spring is restricted to the southeast edge of the Rexburg caldera complex near Heise, Idaho. In this area, the tuff of Elkhorn Spring forms steep cliffs marked by a prominent black, densely welded vitrophyre near the base. The outcrop pattern of the tuff of Elkhorn Spring is roughly arcuate in form and, in part, outlines the southeastern segment of the Rexburg caldera complex ring-fracture zone. The tuff of Elkhorn Spring may have been deposited in a local moat-type depression near Heise along the edge of the caldera.

The tuff of Elkhorn Spring is equivalent to the tuff of Blue Creek, based on petrographic and magnetic similarities as well as distribution characteristics of the volcanic facies (McBroome and others, 1981). Distribution patterns of these two tuff units suggest that their source is a buried caldera located south and east of the southern Lemhi Range and south of the Beaverhead Mountains.

TUFF OF HEISE

The tuff of Heise is a widely distributed and well-exposed Pliocene rhyolite ash-flow tuff sheet that crops out within the Rexburg caldera complex and surrounding mountains. It can be found in the vicinity of Teton National Park, Wyoming, and as far south as Blackfoot, Idaho. The tuff of Heise is the major Pliocene ash-flow sheet in the foothills of the Big Hole Mountains and the Snake River and Caribou Ranges. It is at least 40 meters thick in the Snake River graben near Swan Valley, Idaho. The tuff of Heise varies in thickness from 1 meter to 150 meters, reflecting emplacement onto irregular topography.

The type section has been described by Prostka and Embree (1978) and is exposed at the top of the

Heise cliffs in sec. 30, T. 4 N., R. 41 E., Heise 7½-minute quadrangle. Albee and others (1975) originally described this unit as the tuff of Heise C.

A potassium-argon age of 4.3 ± 0.15 million years has been determined for the tuff of Heise (Armstrong and others, 1980).

The tuff of Heise forms a compound cooling unit (Smith, 1960a, 1960b; Ross and Smith, 1960). In the area of the Rexburg caldera complex, the tuff of Heise consists of four individual partial cooling units. Of these four units, the bulk of the sheet is composed of the lower two units with a thin, capping veneer of the upper sheets. This relationship is best exposed near Heise, Idaho.

The tuff of Heise is compositionally zoned with the plagioclase becoming slightly more anorthitic upward through the sheet.

Petrographic, radiometric, and field studies reveal that the tuff of Heise is equivalent to the tuff of Kilgore, exposed on the northern margin of the eastern Snake River Plain (Troschinetz and Doherty, 1981). The distribution patterns of these tuff units suggest that their source caldera is near Kilgore, Idaho. The tuff of Heise represents the distal facies of the tuff of Kilgore where the tuff of Heise ponded in the Rexburg caldera complex.

MAJOR ASH-FLOW TUFFS ALONG THE NORTHERN MARGIN, EASTERN SNAKE RIVER PLAIN

Initially, the ash-flow tuffs on the northern margin of the eastern Snake River Plain were collectively described as the Edie School Rhyolite (Scholten and others, 1955). Since then, several stratigraphic units have been recognized.

TUFF OF EDIE RANCH

The tuff of Edie Ranch is an extensive ash-flow sheet exposed along the northern margin of the eastern Snake River Plain in the southern Lost River and Lemhi Ranges and southern Beaverhead and Centennial Mountains. The thickness averages 30 meters but ranges from 2 to 3 meters near Kilgore, Idaho, to 100 meters where the unit fills paleovalleys in the Beaverhead Mountains. The type section is in sec. 8, T. 12 N., R. 33 E., Edie Ranch 15-minute quadrangle (Skipp and others, 1979).

Phenocryst content decreases from 15 percent at the base to approximately 5 percent at the top of the unit. Phenocrysts include sodic plagioclase, sanidine, quartz, augite, and zircon; the relative amount of augite increases upward in the sheet. Magnetic remanence direction indicates normal polarity for the tuff of Edie Ranch (McBroome, 1981).

In the southern Lemhi and Lost River Ranges, the tuff of Edie Ranch is the outflow facies of an ash-flow sheet whose source (the Rexburg Caldera) is concealed partially beneath the basalt lava flows of the eastern Snake River Plain. The base of the unit generally consists of reversely graded air-fall ash and pumice. The overlying pyroclastic flow is a crystal-rich, densely welded, simple cooling unit (Smith, 1960a, 1960b; Ross and Smith, 1960). It is dark brown at the base, moderately to densely welded, and grades upward into a basal vitrophyre that is typically bluish black, crystal-rich, and slightly hydrated; a spherulitic zone overlies the vitrophyre. Above the spherulitic zone, the tuff of Edie Ranch is slightly less crystal-rich, has a well-developed lithophysal zone, and grades upward into densely welded, crystal-rich, devitrified tuff, which is capped locally by a thin vitric layer.

At various locations, the tuff of Edie Ranch overlies the tuff of Kyle Canyon (a local tuff of limited extent; Figure 4), alluvial fan gravels, and basalt flows. It is typically in contact with the overlying tuff of Blue Creek where both tuff units rest unconformably on top of Paleozoic sedimentary strata and form gentle, eastward-facing dip slopes.

Preliminary mapping and laboratory studies suggest that the tuff of Edie Ranch is equivalent to the tuff of Spring Creek. Their source is centered near Rexburg, Idaho, in the Rexburg caldera (Prostka and others, 1979).

TUFF OF BLUE CREEK

The tuff of Blue Creek is petrographically and magnetically distinct from the other ash-flow sheets on the northern margin of the plain. The tuff of Blue Creek rests conformably on the tuff of Edie Ranch. It is a crystal-poor, densely welded, glassy to devitrified, spherulitic and lithophysal ash-flow tuff that exhibits features typical of a simple cooling unit (Smith, 1960a, 1960b; Ross and Smith, 1960). It contains an average of 1 percent plagioclase phenocrysts and sparse amounts of pyroxene, magnetite, and zircon. Outflow facies of the tuff of Blue Creek occur in the southern Lemhi Range and the southern Beaverhead Mountains. The thickness varies up to 180 meters and averages 100 meters.

The original description of this unit was made by H. J. Prostka for the Blue Creek area in the southern Beaverhead Mountains (Skipp and others, 1979). A more accessible reference section, which is about 75 meters thick, is exposed in a roadcut on Idaho

Highway 33 at the southern tip of the Lemhi Range (sec. 35, T. 5 N., R. 31 E., Big Lost River 7½-minute quadrangle), where the entire thickness of the unit is exposed. The basal part of the tuff of Blue Creek consists of orange air-fall material overlain by a 1-meter-thick air-fall deposit; exposures of ground surge deposits are present and restricted to the extreme southern portions of the Lemhi Range and Beaverhead Mountains. A pumice-rich, eutaxitic, densely welded zone is characteristic of the lower portion of the tuff of Blue Creek and is easily identifiable by its stretched orange pumice fragments set in a matrix of black glass shards. The lower zone is in sharp contact with an overlying thin vitrophyre layer which, in turn, grades upward into a perlitic, spherulitic tuff zone. A sharp contact separates this spherulitic zone from an overlying devitrified zone which grades upward into a well-developed lithophysal zone at the top of the unit.

The source caldera of the tuff of Blue Creek is most likely located south and east of the Lemhi Range and Beaverhead Mountains (Figures 3 and 5). Evidence that this is the location of the source caldera includes (1) the distribution of near-source deposits; (2) the locations of related rhyolitic lava domes and flows; (3) the locations of caldera-related fault and deformation structures in the southern Lemhi Range and Beaverhead Mountains; (4) lithologic and petrographic data obtained from the exploratory geothermal well (INEL-1) (Figure 2; Doherty and others, 1979; L. A. McBroome and D. J. Doherty, unpublished data, 1981); (5) gravity and magnetic anomaly studies (Mabey and others, 1974); and (6) seismic and resistivity profiles (Pankratz and Ackerman, 1982; A. A. R. Zohdy, personal communication, 1980).

TUFF OF KILGORE

The tuff of Kilgore is exposed along the northern margin of the eastern Snake River Plain from the foothill area east of Howe Peak, in the southern Lost River Range, to the southern flank of the Centennial Mountains north of Kilgore (Figure 1). The tuff has been described as the tuff of Spencer (Skipp and others, 1979). The unit is thickest (100 meters) and apparently nearest to its source along the south side of the Centennial Mountains. It thins to the west, averaging 30 meters thick where it forms extensive dip slopes near Medicine Lodge Creek in the southern Beaverhead Mountains. In that area, the sheet laps onto the older volcanic units, including the tuffs of Blue Creek and Edie Ranch. Farther west the tuff of Kilgore is found in scattered patches in the foothills of the southern Lemhi Range and southern Beaverhead Mountains. It is generally less than 2 meters thick in most of these areas.

The tuff of Kilgore is a simple cooling unit. The basal vitrophyre is fairly thin (less than 1 meter) and is densely welded with a red and black matrix containing abundant black shards, sparse, black to light gray pumice, and 5 percent black and red grains of obsidian.

A lithophysal zone which constitutes about one-third of the thickness of the unit overlies the vitrophyre. Small (0.5 to 5 centimeters), white lithophysae make up about 50 percent of the rock, whereas the remainder is a medium gray, devitrified, densely welded tuff. Because the tuff is generally massive with little or no jointing, the lithophysal zone commonly forms a prominent cliff, whereas adjacent zones are eroded away or concealed by soil and colluvium.

The central part of the unit above the lithophysal zone is devitrified and slightly eutaxitic, has pronounced slabby parting, and generally displays a strong lineation on joint surfaces. Where the rock is nonlineated, it contains a few lithophysae which are larger than those in the lithophysal zone below. Lineations in the platy zone consist of white and maroon streaks up to 30 centimeters long, 1 to 3 centimeters wide, and only a millimeter or so thick. The streaks consist predominantly of vapor phase crystals. The near absence of large pumice fragments in other parts of the unit and at locations where the platy zone shows no lineation suggests that the lineated streaks may be stretched lithophysae produced by secondary flow.

The uppermost zone, where it has not been removed by erosion, is pink to red, vitric, and moderately welded. The vitric tuff contains light gray, silky pumice, red and black obsidian grains, and black shards like those in the basal vitrophyre.

In the more distal area to the west in the southern Lemhi Range, the tuff is dominantly vitric. Where the lithophysal and devitrified zones are missing, the sheet is only a meter or two thick.

The phenocryst content of the tuff of Kilgore ranges from 5 to 7 percent at the base of the unit to approximately 1 to 2 percent at the top. The predominant phenocryst mineral is plagioclase. In addition, sanidine, quartz, and very sparse, tiny, dark green augite crystals occur as rare phenocrysts.

SUMMARY

The preliminary stratigraphic framework of five major, large-volume ash-flow sheets exposed along the northern and southeastern margins of the eastern Snake River Plain includes descriptions of the tuff of Arbon Valley, the Walcott Tuff, and the tuffs of Edie

Ranch, Blue Creek, and Kilgore. The lithologic character and stratigraphic sequence of some of the ash-flow tuffs on the margins of the eastern Snake River Plain suggest the following correlations: (1) The tuff of Edie Ranch is equivalent to the tuff of Spring Creek and their eruptive source is the Rexburg caldera. (2) The tuff of Blue Creek and the tuff of Elkhorn Spring are equivalent; the tuff of Blue Creek represents the near-source, outflow facies, and the tuff of Elkhorn Spring represents the distal facies; the eruptive center for these units is on the northern margin of the eastern Snake River Plain south and east of the Lemhi Range and south of the Beaverhead Mountains. (3) The tuff of Kilgore is equivalent to the tuff of Heise; the tuff of Kilgore is the near-source facies whereas the tuff of Heise is the distal facies; the relationship of the facies suggests that the eruptive center for these units is located near Kilgore, Idaho.

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